Final Report

Individualized Science Experiments I and II

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Overview

Because of the lack of appropriate educational aids, many activities presented in highly visual texts cannot be demonstrated to blind students by teachers nor can related experiments be performed independently by blind students. An attempt to meet the need for specialized educational aids in science has been conceptualized in terms of laboratory components which can be utilized to introduce basic science concepts earlier and more effectively than has been possible in the past. Experiments have been developed which afford blind students personalized experience in science at an early age and which promote their independence in exploration and discovery in science.

The American Printing House for the Blind (APH) has developed a light sensor (Franks & Sanford, 1976a) which affords blind students opportunities for direct observation, experimentation, and discovery. The sensor produces an auditory signal of varying pitch as a result of its exposure to intensity of light. By focusing the light sensor on apparatus used in many basic science experiments, the student is able to receive immediate feedback. The light sensor has been used successfully by blind students in elementary grade science classes and with students in primary grades. Twenty-five hands-on experiments performed by primary grade blind students have been compiled and are available in an APH manual (Franks & Sanford, 1976b). The experiments utilize apparatus normally found in the school and classroom.

Individualized Science Experiments

Eight individualized science experiments were developed and assembled to introduce personalized experiences to young blind students. The experiments emphasize hands-on concrete experiences which are typical of the change in direction of elementary science instruction in recent years. These are

supplementary science materials to stimulate students into discovery and inquiry in science. The experiments present basic concepts and can be performed by students prior to covering the text material, can be used with the text unit, or can be performed when the unit is completed. Each experiment introduces a fundamental concept and/or process (e.g. setting up a controlled experiment) in science and has the student perform one or more experiments with the materials provided. The concept of a variable and the effect of changing variables are emphasized. "Challenges" are included which reinforce both the scientific concepts and the processes discussed in the experiment. These challenges generally involve setting up a controlled experiment.

Individualized light experiment units (Individualized Science Experiments II) using the APH light sensor were identified and mock-up models were constructed as part of a light sensor project in Fiscal 1976. These experiments were developed to enable blind students to perform more sophisticated laboratory operations than those performed in either the introductory experiments compiled for young blind students in the APH Light Sensor Manual or in the eight Individualized Science Experiments I (Schatz, Franks, Their, & Linn, 1976) developed in Fiscal 1975. The experiments in the light sensor manual were developed to introduce the light sensor and hands-on activities (with teacher guidance) to young blind students. The Individualized Science Experiments I provide blind students hands-on experiences which they can perform independently without the light sensor. Individualized Science Experiments II utilize components from both projects: The experiments are individualized, and they use the APH light sensor plus additional specialized equipment.

Individualized Science Experiments I

A. Problem requiring solution

APH contracted with Lawrence Hall of Science, University of California,

Berkeley, in 1974 to develop science activities (Schatz, Franks, Thier, & Linn, 1976) for elementary students. The activities and materials were to be compatible with curriculum content in current science textbooks. Small class sizes and large individual differences in the visually handicapped population made it preferable to think about producing activities for use by one or two students. Other considerations were: A minimum of teacher intervention, maximum student exposure, and opportunities for student choice. Personalizing the activities was considered important because:

1) Students could work on activities appropriate for their developmental level.
2) Students could develop independence in working with equipment and various scientific concepts.
3) Teachers would be free to work individually with some students while others could work independently or in small groups.
4) The materials could be incorporated into a teacher's own style and curriculum.

B. Principal and subordinate objectives

The principal objective of this project was evaluation of eight experiments (activities) to determine their appropriateness for use with young blind students.

C. Materials

The Individualized Science Experiments I kit contains eight experiments. A list of experiments with descriptors and questions that the student answered in performing the experiment follows:

1) PUMPING PULSE--a pulse rate experiment: Is an older person's pulse rate slower or faster than yours?
2) USING A STETHOSCOPE--a hearbeat experiment: Can you use the stethoscope to hear a heartbeat?

3) PLAY IT BE EAR--a sound experiment: Does the ticking of a clock or timer sound louder when you listen to it through a stethoscope?

4) BOTTLE SOUNDS--a sound experiment: Can you make two different sounds using two bottles of the same size?

5) CATCH YOUR BREATH--a breathing experiment: What effect does running in place have on the time it takes for you to breathe 10 times?

6) HELLO HEART--a heartbeat experiment: Does your heart beat faster when you stand up or lie down?

7) FOOT FACTS--a linear measurement experiment: Does a person who is several centimeters taller than you have a longer or shorter right foot than you?

8) EVERY SECOND COUNTS--a time experiment: How long is 30 seconds?

D. Procedure

Each activity was tested in trials in actual classroom situations in several different settings. The science specialist at the California School for the Blind used the materials in his regular classes. Five to seven students each worked on a different activity while the specialist interacted individually with students. A resource room teacher at Proctor School in Castro Valley, California, set up a science corner in her classroom. She had each activity on tape and students worked on experiments independently, coming to her only when they had a question. She usually followed up the activity with some questions to determine how they liked the experiment and to find out what they learned. Occasionally, her students brought in material or took some of the equipment home to expand on the topic being discussed. This was also true of a class at Earl Warren Junior High in Castro Valley where the teacher utilized the activities as a way

of encouraging language development for two of his students with reading difficulties.

The eight most promising experiments were reviewed at APH. Additional editing and adaptation occurred. Further field evaluation in the form of a teacher critique-in-use with blind students was conducted. Six science teachers of elementary grade blind students used the experiments over a six month period. Their overall evaluations considered the appropriateness of the experiments based on student performance.

D. Results

Teachers and students alike were enthusiastic about the experiments. Students generally used braille and large print copies in performing the experiments. Some teachers, however, taped or read the experiments to reduce the amount of hand movement required by students in performing the experiments (e.g. movement from copy to equipment back to copy). More than 50 students performed each of the experiments produced. Considerable editing was required in finalizing the experiments for publication and distribution.

Between 25 and 30 percent of the students were in primary grades. Although many of these students had not mastered the braille code, they were able to perform the experiments using taped copies or by having the experiments read to them.

Following are recommendations incorporated in the final editing and preparation of the experiments.

1) "Simplify" the experiments by presenting only one concept in each experiment with several related activities to reinforce the concept presented.
2) "Simplify" the language so younger students can perform the experiments with less explanation from the teacher.

3) Consider taping the experiments and making them available on cassettes.

4) Include as many of the materials/equipments as possible with the experiments.

5) Develop additional individualized experiments in concept areas other than those included in these experiments.

Individualized Science Experiments II

A. Problem requiring solution

Four light experiment units using the APH light sensor were identified and mock-up models were constructed as a part of a light project in Fiscal 1976. Subsequently, pilot trials with these models were conducted at the Florida School for the Blind to determine if blind students could use the models to perform basic concepts on light. These concepts were identified through informal inspection of available series of science textbooks. The format for individualizing the experiments was refined. Evidence was found that students were able to use the models following the individualized format.

B. Principal and subordinate objectives

The principal objectives of the project were:

1) The evaluation of four science modules (8 experiments) presented on cassette tapes, and

2) The revision of the experiments, the aids, and the tapes as indicated from the evaluation.

A subordinate objective was to critique a fifth module on transparency to include in the experiment package, if time permitted.

C. Materials

The Individualized Science Experiments II materials consist of five units of

two experiments each. A list of experiments with descriptors and questions which the student answered in performing the experiment follow. (The number of students performing each experiment is presented at the left.)

1) HOW LIGHT TRAVELS

(N=35) a) The light sensor can detect a beam of light: Can you point the sensor directly into the beam of light coming from the flashlight?

(N=35) b) A beam of light travels in a straight line: Can you center the holes in three cards to let a beam of light pass through them in a straight line?

2) LIGHT REFLECTION USING MIRRORS

(N=39) a) Using a mirror to reflect light: Can you reflect light using a mirror?

(N=43) b) Using two mirrors to reflect light: Can you reflect light using two mirrors?

3) LIGHT POLARIZATION

(N=37) a) Blocking a beam of light: Can you arrange two transparent squares in a way that they will block light from passing through them?

(N=38) b) Block that light--a demonstration: Can you arrange two raised-lined cards to demonstrate how polarized light waves are blocked?

4) INTRODUCTION TO LIGHT REFLECTION

(N=43) a) The surface of an object may reflect or absorb light: Can you arrange three cards in order according to the amount of light reflected by each card?

(N=36) b) A flashlight is an energy source which projects light: Can you take a flashlight apart and put it together again

correctly?

5) TRANSPARENCY

(N=20) a) Identifying transparent and opaque objects: Can you identify transparent and opaque pieces using a light box?

(N=20) b) Distinguishing between transparent and translucent objects: Can you separate translucent pieces from transparent pieces, using a light box?

The TRANSPARENCY experiments and the light box were evaluated by teachers during the final interview, consequently, the number of students who used the light box is smaller.

D. Procedure

Field evaluation of the experiments consisted of a critique-in-use by eight teachers who used the materials and equipment with available legally blind elementary grade students in grades 4-8. This procedure was successfully utilized in evaluation of Individualized Science Experiments I described in an earlier section of this report. The overall evaluation relied on each teacher's consideration of the appropriateness of the experiments based on student performance.

E. Results

Teachers and students who participated in the evaluation expressed enthusiasm for the experiments, and particularly for the taped programs. The overall quality of the tapes was considered excellent. The reader read slowly and clearly. There were sufficient pauses, except between items in the equipment section. Although the following suggestions were made in the portion of the student and teacher interviews, they do not relate specifically to the quality of the taped material.

1) The one unanimous suggestion from all interviews was shortening the excessive lead-in time on each tape. The experiment presentation should begin earlier on each tape.

2) A longer pause should be allowed between each item in the equipment section. Students had to stop the tape immediately after a piece of equipment was named and find the piece. Often, a second, or even third piece of equipment was named before the student was able to stop the tape. Consequently, time was lost with numerous rewinds and replays of the equipment sections.

3) In several interviews the suggestion that a slightly longer pause be allowed at the end of each section was made. Students were sometimes into the next section before realizing that the previous section had ended. A "bong" or musical sound was suggested by some students as a cue that a section has ended.

4) More frequently, students suggested that some cue indicating the end of an experiment be used. A large unused portion of tape remained on each spool which led a number of students to think that additional information remained on the tape.

The content of the taped experiments was rated very high. Teachers were generally pleased with the format and with the ease students were able to understand what an experiment was about. The experiment title related the experiment to a concept, and the question posed oriented the student to the primary activity to be performed. Students had more difficulty with the first experiment they performed, but teachers agreed that the best way of learning the procedures "is to actually perform and experiment."

A number of editorial notations were made for minor changes and for guides in a final review of the experiments. No major change was suggested for any experiment. The content has been reviewed and some minor editing has occurred, primarily because of changes caused by use of some pieces of equipment (e.g. student had to stop the tape to replace the flashlight holder on the tray and/or realign the light sensor in its holder). No general criticisms on the sequence

of activities were made.

A list of specifications for production of equipment has been compiled. The specifications are based on suggestions of teachers and students who experienced a number of difficulties in utilizing several pieces of the equipment--particularly with the various holders.

Consistently across interviews, students and teachers recommended that the equipment be labeled, organized, and packaged by experiment unit. Students and teachers recommended that each unit of two experiments should be packaged separately with the contents of each package indicated in braille and large print on the outside of the container.

Teachers and students requested that a set of reference copies of the experiments in large print and braille be included. Teachers want the copies to familiarize younger students with an experiment prior to performing it, to introduce specialized vocabulary, and to teach reading in science (e.g. following directions). Students want copies for reference work, to check spelling of new vocabulary words and to use for reference or library work before and/or after an experiment has been completed. A copy saves time if the student has completed an experiment one day and wishes to work on a challenge the next day.

Teachers and students all requested more experiments. They want more experiments at the elementary grade level--across science areas--to provide hands-on concrete experiences to introduce each unit of study. No such experiments are available in many areas of life science, earth science, and physical science. Older students also requested more advanced experiments.

Conclusions

Critiques by science teachers who used the Individualized Science Experiments I with blind students indicate that: Young blind students--as early as the primary grade level--can perform a number of concept-related activities

independently in laboratory science if the conceptual information is broken down into small steps, if appropriate educational aids are made available, and if sufficient time is given the student to learn to manipulate the aids and apparatus used in the experiments.

The success of young blind students in using the APH Light Sensor and in performing Individualized Science Experiments II reported in teacher critiques supports the hypothesis that: Blind students can utilize the light sensor and additional specialized apparatus to perform sophisticated individualized light experiments which previously have not been available to them because of the highly visual nature of experiments in light.

The enthusiastic responses and requests for individualized science experiments such as those developed in the project support the development of additional science experiment modules across life science, earth science, and physical science. Special attention should be given to those units of study for which no concrete hands-on materials and experiments are available.

References

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